If r^1 be the rate per cent. per annum yielded by the rent of a piece of land, and r be the rate per cent. per annum of the increment in its value—

If V^1 be the price originally paid for land, V_2 the value after n years, then the value of r is obtained from the equation—

$$\log.\ (1 + r) = \frac{\log.\ V_2 - \log.\ V_1}{n}$$

If R be value of r obtained from this equation, then $R + r$ is the annual rate per cent. received by the investor on his money.

Art. IX.—*Hughes' Induction Currents Balance and Sonometer.*

By Robert E. Joseph.

[Read 14th August, 1879.]

On the 15th of May last Professor Hughes read before the Royal Society, in London, a paper on "An Induction Currents Balance, and Experimental Researches made with it;" and the subject appeared to me to be of so much interest, and capable of being utilised to a very great extent in physical research, that I considered a few notes on the matter would prove acceptable to the members of our own Society.

Attempts have frequently been made to construct induction-balances for many years past; but they do not appear to have given satisfactory results. The introduction of the telephone, however, as an instrument that will detect currents of too feeble a nature to be detected by any other instrument, has caused what before was found to be a difficulty to now become quite easy, besides being simple and reliable.

The instruments I introduce to your notice this evening are the induction-balance, sonometer, clock-microphone, and telephone, which, with a battery and reversing key, will enable us to make any experiments we may require. Before, however, proceeding with these experiments, it will be as

well, I think, to describe the nature of the apparatus for the benefit of those who may not have read the paper I before referred to.

The induction-balance consists of two small wooden cups, having a couple of spools, on each of which is wound about 100 yards of 36 silk-covered wire; the lower bobbins are fixed, and form the primary circuit; the upper ones are adjustable, and form the secondary circuit.

If we now join the primary coils together, placing in their circuit a battery and microphone on which is placed a small clock, and join the secondary coils together with a telephone in its circuit, we shall, on listening, hear the clock ticking by the action of the current induced in the coils. If we now arrange the upper coils in such a way that they oppose each other, we can, by adjusting the distance between them, arrive at a zero-point at which we shall fail to hear the faintest sound of the microphone. In this state the balance is fit for use, for, if we introduce any metallic substance in either of the cups, we immediately disturb the balance and hear the clock ticking with an intensity of sound that depends not only on the nature of the substance introduced, but also by its weight or bulk.

Suppose we place a piece of silver in one cup, it will give out an intense sound; and we find that we must place in the other cup a piece of silver exactly alike, as regards size, weight, standard, &c., to balance the coils that are to produce the silence point again; and so sensitive is the instrument, that, with 24 Leclancher's cells, I have not yet succeeded in balancing exactly any two silver coins, although I used perfectly new ones for the experiment. Gold ones were much easier to balance, using the same battery; but the sound given out by a gold coin is not nearly so intense as that of silver, and I am inclined to think that it will be necessary to use a larger battery with different metals; because, it appears to me, that, in balancing any metals by sound, we of course depend upon the delicacy of our sense of hearing. When the balance arrives at nearly its zero-point we may not be able to distinguish any sound with, say, a battery of 20 cells; but by doubling the battery-power we increase the sound in the microphone, and thus render the instrument more sensitive. I should like to try the effect of a large battery, say, of 40 or 50 "Groves," on a balance, the primary coils of which were wound with coarse wire, as I imagine this would detect

even small differences in alloys which are not perceptible in using a weak battery-power.

For the purpose of making a perfect balance it is necessary that both coils should be exactly alike as regards size and length of wire; it also requires that the substance to be measured must be placed exactly in the centre between the coils. I find you can produce a difference in the intensity of the sound by varying the position of the substance, the loudest being, as I before stated, when the article is in between the centre of the coils.

The sonometer, which is used in conjunction with the balance, is similar in construction and action.

It consists of two primary coils, sliding between which is the secondary coil, the primary coils being wound so as to oppose each other. It follows that if both coils were the same as regards length and size of wire, the centre would be the zero or silence point; but in the one under your notice I have wound them of different lengths, so as to obtain a wider range of measuring.

By means of this instrument we can obtain the exact value of any person's hearing powers, which, as you will presently see, varies very considerably.

The use of this instrument alone appears to me to open up a very interesting subject of research. I am unaware of any other instrument that will enable us to ascertain and tabulate the strength of our hearing powers, from day to day, or to compare the sensitiveness of our sense of hearing. Suppose, now, we join the sonometer in circuit with the balance, placing in its circuit a reversing key, so arranged that we can switch-on either the balance or the sonometer. If we now place any substance in the balance we get a sound of a certain intensity; and by switching-in the sonometer, and adjusting its secondary coil, until we obtain a sound of similar intensity, we can read off the value of that substance; and so sensitive and accurate is its performance, that with a very little practice we are enabled to detect the nature of the metal, although we need not see it placed in the balance. Again, we may obtain the sound value of a coin; it will then be only necessary, supposing any one were to place an unknown number of coins in the balance, to obtain the sound value of the total number, and we can easily calculate the nature and number of coins placed in the balance. To ensure this expriment being satisfactory, it is necessary to adjust both coils at a much

further distance apart, so as to still bring the increased mass of metal in the centre of the coils.

I have been experimenting up to the present time with a view of being able to obtain visual instead of acoustic results, but so far without decided success; the extreme feebleness of the induced current as it approaches its zero-point fails to influence any form of galvanometer; and although the principle can be exhibited by a very sensitive form of galvanometer when a considerable disturbance of the balance takes place, the practical value of the balance is lost by its insensitiveness.

I think I have now explained sufficiently the construction of the apparatus; it is so easily made and used that it should find a place in all future physical researches, and thus by extending its use we may discover its exact value as a new instrument of measurement.

Art. X.—*Notes on the Geology of the West Tamar District, Tasmania.*

By Norman Taylor, of the late Geological Survey of Victoria.

[Read 9th October, 1879.]

The country which I examined in the month of January last contains an area of about forty square miles in the parish of Phillipsnorton, county of Devon, Tasmania. It is situated in the neighbourhood of the West and Middle arms of the River Tamar, a district which at one time gave promise of being a large iron-producing one, but which has, unfortunately, after several trials and much wasted capital, been temporarily abandoned, simply from the unforeseen occurrence in the iron ores of an *oxide of chromium*, the presence of which renders it impossible to turn out good marketable pig iron.

The roughly triangular area, whose base would join the heads of the West and Middle arms of the Tamar, consists at its northern apex of greenstone, rising at Ilfracombe village to a long ridge, capped with older pliocene tertiary